

Bell Work

7-Feb-2017

Balance the following equation;



How many moles of Aluminum Oxide
are produced from the combustion of
3 moles of Aluminum (think about the
balanced equation and a molar ratio)

What about grams of O_2 needed?



Objective:

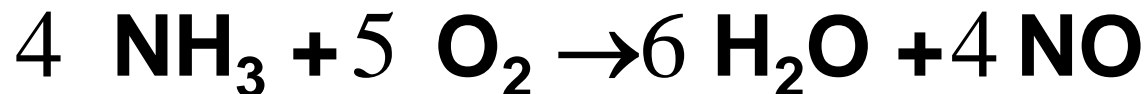
You will be able to set up a mole bridge using a balanced equation.

**EQ: How does being confident
in only part of a very large
number impact results**

Stoichiometry

Stoichiometry

Balance the following equation:

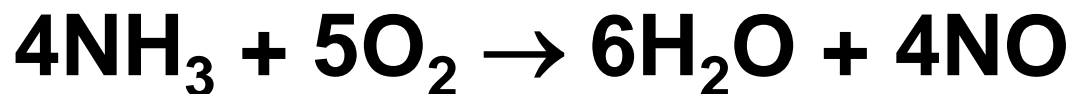


What is the ratio between ammonia and nitrogen monoxide? **4:4 or $\frac{4 \text{ mol NH}_3}{4 \text{ mol NO}}$**

What is the ratio between Nitrogen monoxide and oxygen? **4:5 or $\frac{4 \text{ mol NO}}{5 \text{ mol O}_2}$**

So for every 4 mol of NO you have 5 mol of O₂.

Stoichiometry



So many conversion factors exist:

4 mol NH₃/5 mol O₂, 6 mol H₂O/4 mol NH₃, etc

What if you had 2 mol of NO, how many moles of O₂ would you have?

$$2\text{mol NO} \times \frac{5\text{mol O}_2}{4\text{mol NO}} = 2.5\text{mol O}_2$$

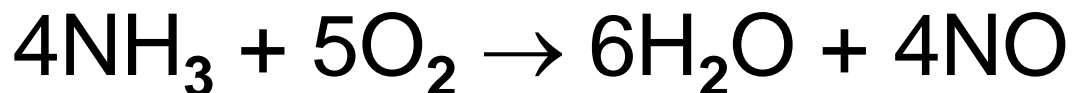
What if you had 6 mol of H₂O, how many moles of O₂ would you have?

$$6\text{mol H}_2\text{O} \times \frac{5\text{mol O}_2}{6\text{mol H}_2\text{O}} = 5\text{mol O}_2$$

Stoichiometry

“Stoichiometry” refers to the relative quantities of moles. It also refers to calculations that make use of mole ratios.

Stoichiometry



Recall also that molar masses provide factors:

$$\frac{1 \text{ mol NH}_3}{17 \text{ g NH}_3}$$

$$\frac{32 \text{ g O}_2}{1 \text{ mol O}_2}$$

Is $\frac{4 \text{ g NH}_3}{5 \text{ g O}_2}$ a conversion factor?

No!

The equation tells us moles not grams.

Stoichiometry Question 1a

Consider : $4\text{NH}_3 + 5\text{O}_2 \rightarrow 6\text{H}_2\text{O} + 4\text{NO}$

How many moles of H_2O are produced if 0.176 mol of O_2 are used?

$$\begin{aligned} \# \text{ mol H}_2\text{O} &= 0.176 \cancel{\text{ mol O}_2} \times \frac{6 \text{ mol H}_2\text{O}}{5 \cancel{\text{ mol O}_2}} = \\ &0.21 \text{ mol H}_2\text{O} \end{aligned}$$

Notice: A correctly balanced equation is essential to get the right answer

Stoichiometry questions (1b)

Consider : $4\text{NH}_3 + 5\text{O}_2 \rightarrow 6\text{H}_2\text{O} + 4\text{NO}$

How many moles of NO are produced in the reaction if 17 mol of H_2O are also produced?

$$\begin{aligned} \# \text{ mol NO} = & \cancel{17 \text{ mol H}_2\text{O}} \times \frac{4 \text{ mol NO}}{\cancel{6 \text{ mol H}_2\text{O}}} = \\ & \mathbf{11.33 \text{ mol NO}} \end{aligned}$$

Notice: A correctly balanced equation is essential to get the right answer!

Recall

What is essential to perform stiochiometry?

Stoichiometry questions 1c

Consider : $4\text{NH}_3 + 5\text{O}_2 \rightarrow 6\text{H}_2\text{O} + 4\text{NO}$

How many moles of NH_3 are needed in the rxn if 0.5 mol of H_2O are also produced?

$$\begin{aligned}\# \text{ mol NH}_3 &= 0.5 \text{ mol H}_2\text{O} \times \frac{4 \text{ mol NH}_3}{6 \text{ mol H}_2\text{O}} \\ &= 0.33 \text{ mol NH}_3\end{aligned}$$



This is what
anhydrous
ammonia will do
to your skin

The “Mole Bridge”

The Mole Bridge is used to convert from one type of compound to another via their molar ratio based on a *Balanced* equation.

You have just converted from one type of compound to another in moles.

Now what if you wanted to go from moles of one compound to grams of another?

The “Mole Bridge”

Now what if you wanted to go from moles of one compound to grams of another?

Moles of A → grams of B

$$\cancel{\text{mol A}} \times \boxed{\frac{\cancel{\text{mol B}}}{\cancel{\text{mol A}}}} \times \frac{\text{Molar Mass B}}{\cancel{1 \text{ mol B}}} = \text{grams B}$$

The Mole Bridge



Your Turn

Consider : $4\text{NH}_3 + 5\text{O}_2 \rightarrow 6\text{H}_2\text{O} + 4\text{NO}$

How many grams of H_2O are produced if 1.9 mol of NH_3 are combined with excess oxygen?

$$\begin{aligned} \# \text{ g H}_2\text{O} = & 1.9 \text{ mol NH}_3 \times \frac{6 \text{ mol H}_2\text{O}}{4 \text{ mol NH}_3} \times \frac{18 \text{ g H}_2\text{O}}{1 \text{ mol H}_2\text{O}} = \\ & 51 \text{ g H}_2\text{O} \end{aligned}$$

Your Turn

Consider : $4\text{NH}_3 + 5\text{O}_2 \rightarrow 6\text{H}_2\text{O} + 4\text{NO}$

How many grams of O_2 are required to produce 0.3 mol of H_2O ?

$$\begin{array}{l} \# \text{ g O}_2 = \\ 0.3 \text{ mol H}_2\text{O} \times \frac{5 \text{ mol O}_2}{6 \text{ mol H}_2\text{O}} \times \frac{32 \text{ g O}_2}{1 \text{ mol O}_2} = 8 \text{ g O}_2 \end{array}$$

Before You Go

Write out the steps for completing stiochiometry.

HW:

Read p. 233-237

Work out all examples and complete #28-32

Bell Work, 9-FEB-2017

1. Please write the balanced chemical equation for the reaction of **Iron** and **Copper (II) Sulfate**.
2. Why type of reaction is this?
3. What is the mole:mole ratio of Iron to Copper?
4. Cal. the mass of Iron needed to produce 0.60 g Copper.
5. **Start reading Lab introduction and procedures – Put together a pre lab**

Bell Work

10-Feb-2017

**If lead (II) nitrate reacts with potassium iodide
what are the two products?**

Write out a balanced equation

What type of reaction is this?

**If you have 2moles of lead (II) nitrate how
many grams of potassium iodide would you
need for a complete rxn?**



Objective:

Implement stoichiometry principles to predict actual quantities in a laboratory experiment

To examine theoretical and actual yields in the lab.

Fe/ CuSO₄: Day 1

Safety: CuSO₄ (**CuSO₄ · 5H₂O**) is mildly toxic

Try not to decant any of the solid out of the rxn beaker.



FOLD FILTER PAPER IN HALF



FOLD INTO QUARTERS WITH TOP SECTION SMALLER THAN BOTTOM

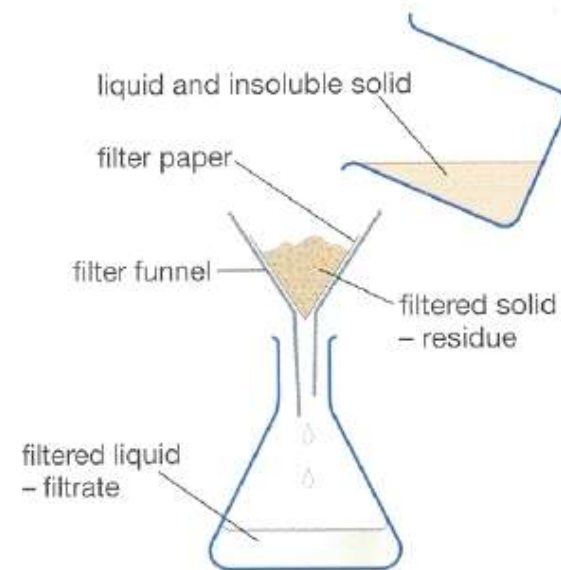


TEAR OFF CORNER OF SMALLER SECTION



OPEN CONE

Label and then weigh the filter paper before filtering



Fe/ CuSO₄: Day 2

Dispose of solid waste in labeled container in hood

Then finish post lab for homework.

Objective – you will be comfortable
converting from grams of one substance to
grams of another in a balance equation

Moving along the stoichiometry path

Given: $4\text{NH}_3 + 5\text{O}_2 \rightarrow 6\text{H}_2\text{O} + 4\text{NO}$

- a) How many moles of H_2O can be made using 0.5 mol NH_3 ?**
- b) What mass of NH_3 is needed to make 1.5 mol NO ?**
- c) How many grams of NO can be made from 120 g of NH_3 ?**



Converting grams \leftrightarrow grams

Notice that we cannot directly convert from grams of one compound to grams of another. Instead we have to go through moles.

Many stoichiometry problems follow a pattern:

$$\text{gram(A)} \leftrightarrow \text{mol(A)} \leftrightarrow \text{mol(B)} \leftrightarrow \text{gram(B)}$$

grams of A \rightarrow grams of B

Converting grams \leftrightarrow grams

Many stoichiometry problems follow a pattern:



grams of A \rightarrow grams of B

$$\boxed{\text{gram A} \times \frac{1 \text{ mol A}}{\text{MM A}}} \times \boxed{\frac{\text{mol B}}{\text{mol A}}} \times \boxed{\frac{\text{MM B}}{1 \text{ mol B}}} = \text{grams B}$$

**Grams A to
Moles A**

Mole Bridge

**Moles B to
Grams B**

Your Turn... You need to think a little harder!

Consider : $4\text{NH}_3 + 5\text{O}_2 \rightarrow 6\text{H}_2\text{O} + 4\text{NO}$

**How many grams of NO is produced if
12g of O_2 is combined with excess
ammonia?**

g NO=

$$\begin{aligned} 12 \text{ g } \text{O}_2 & \times \frac{1 \text{ mol } \text{O}_2}{32 \text{ g } \text{O}_2} \times \frac{4 \text{ mol NO}}{5 \text{ mol } \text{O}_2} \times \frac{30 \text{ g NO}}{1 \text{ mol NO}} \\ & = 9.0 \text{ g NO} \end{aligned}$$

Converting grams to grams

grams(A) \leftrightarrow moles(A) \leftrightarrow moles(B) \leftrightarrow grams(B)

We can start anywhere along this path

So, for the rxn $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$ what is the path we would take for the following

Given 2 mol H_2O , calculate grams H_2O ?

Moles O_2 required for 36 g H_2 ?

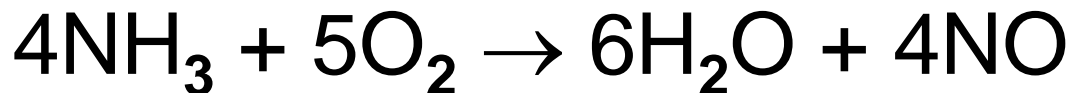
Grams of H_2O produced from 6g O_2 ?

36g

9moles

6.75g

Answers



a)

$$\# \text{ mol H}_2\text{O} = 0.5 \text{ mol NH}_3 \times \frac{6 \text{ mol H}_2\text{O}}{4 \text{ mol NH}_3} = 0.75 \text{ mol H}_2\text{O}$$

b)

$$\# \text{ g NH}_3 = 1.5 \text{ mol NO} \times \frac{4 \text{ mol NH}_3}{4 \text{ mol NO}} \times \frac{17.04 \text{ g NH}_3}{1 \text{ mol NH}_3} = 25.6 \text{ g NH}_3$$

c)

$$\begin{aligned} \# \text{ g NO} = \\ 120 \text{ g NH}_3 \times \frac{1 \text{ mol NH}_3}{17.04 \text{ g NH}_3} \times \frac{4 \text{ mol NO}}{4 \text{ mol NH}_3} \times \frac{30.01 \text{ g NO}}{1 \text{ mol NO}} \\ = 211 \text{ g NO} \end{aligned}$$

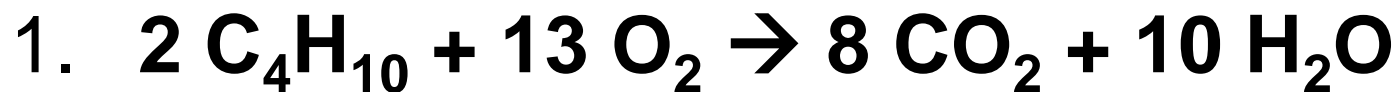
Small Group

Stoichiometry Practice #2,

You will complete Stoichiometry Practice #2
in a small group.

As a team, work out each problem on white
boards, showing all work.

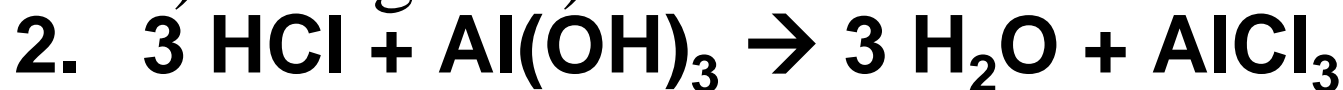
More Stoichiometry Questions



a) What mass of O_2 will react with 400 g C_4H_{10} ?

b) How many moles of water are formed in a)?

a) 1434g b) 34.5moles



How many grams of aluminum hydroxide will react with 5.3 moles of HCl ? 137.8g



What mass of O_2 results from the decomposition of 1.00 kg of calcium chlorate? 466g

Continued

4. $\text{Fe}_2\text{O}_3 + 3\text{CO} \rightarrow 2\text{Fe} + 3\text{CO}_2$. a) 3.09g b) 28.3g
- A) How many moles of carbon monoxide are required to react with 163.0 g of iron(III) oxide?
- B) How many grams of CO_2 are produced from a reaction that also produces 23.9 grams of Fe?
5. $3\text{Cu} + 8\text{HNO}_3 \rightarrow 3\text{Cu}(\text{NO}_3)_2 + 4\text{H}_2\text{O} + 2\text{NO}$
- A) How many moles of copper(II) nitrate can be prepared from 17.0 moles of Cu?
- B) How many grams of copper(II) nitrate can be prepared using 3.8 moles of HNO_3 ?
- C) What mass of water results from the reaction of 8.50 kg of copper metal?

EQ: Week four into the new semester...how have you been doing in your goal to do better in this course this semester compared to last? What is one thing you can still improve upon to continue to improve?

Objective:

Use an online program to practice finding limiting reagents

<http://phet.colorado.edu/en/simulation/reactants-products-and-leftovers>

Before you go...

Write four (4) sentences dealing with how you will use stoichiometry to solve chemical calculations and the steps involved with stoichiometry in your own word W/O looking at your notes.



Bell Work

13-Feb-2017

1. Name the following compounds:



2. What are the molar masses of each compound?

3. What do the coefficients in front of species in a balance equation represent?

Agenda

Percent Yield

Finish Lab, Day 1

Objective:

You understand that some reactants run out before others and will be able to determine the limiting reagent in a reaction

Percent Yield

Rxns rarely produce the predicted amount of product from the masses of reactants in the rxn.



An example of this is the rxn of CuSO_4 with Fe. Normally we expect a 1 mol yield of Cu for every mol of Fe reacted. This does not always happen.

Percent yield

If you react 55.8 g of Fe to make Cu, the amount of Cu expected is 1 mol of Cu or 63.5 g of Cu.



Sadly the amount you get will probably be < 63.5g say, 50 g of Cu. The problem is a competing rxn or complexing of a Cu²⁺ ion that happens.

Percent Yield

The Cu^{2+} participating in this “complexing” will not be able to make Cu. The reaction will not yield 100% of the expected Cu.

The amount of Cu produced, ~50 g is only 78.7% and not 100 % of the expected 63.5 g.

Percent yield = $100 \times \frac{50 \text{ g Cu actual}}{63.5 \text{ g Cu predicted}} \rightarrow 78.8\%$

Percent Yield

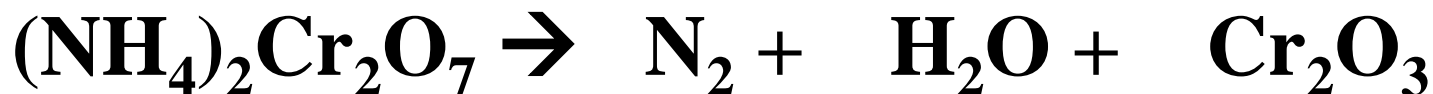
$$\text{Percent yield} = \frac{\text{Actual yield}}{\text{Theoretical yield}} \times 100$$

What is the percent yield for a rxn if you predicted the formation of 21 g of C₆H₁₂ and actually recovered only 3.8 g?

$$\text{Percent yield} = 100 \times \frac{\text{3.8 g C}_6\text{H}_{12} \text{ actual}}{\text{21 g C}_6\text{H}_{12} \text{ predicted}} \rightarrow 18\%$$

Percent Yield Practice

When the following rxn is called a mini “volcano”



Balance it

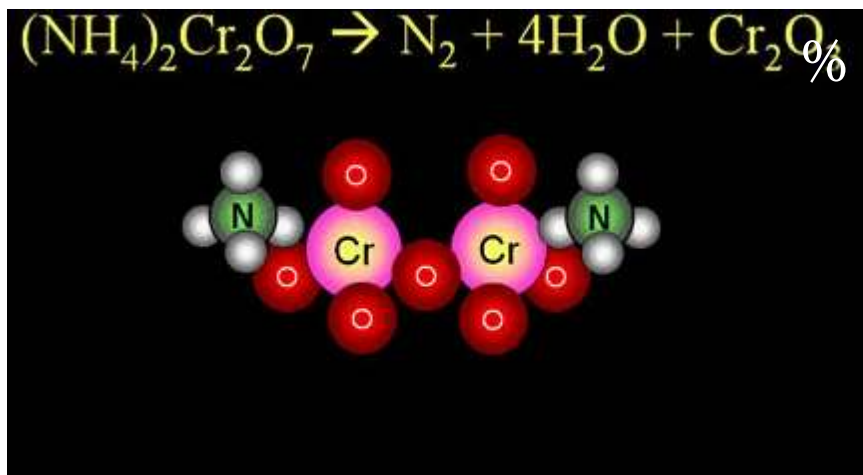
What type of reaction is this?

When 3.0g of the reactant is heated how many grams of the chromium containing product would you expect to get?



Percent Yield Practice

When the following reaction takes place it is called a mini “volcano”



If we actually got 1.1g of chromium (III) oxide, what is our percent yield?

Bell Work, 14-Feb-2017

- a. What does the term “limiting” mean?
- b. What is “non-limiting”?**
- c. When you are finished please goggle up and weight your product from the “Fe/ CuSO_4 ” lab. Dispose of solid Cu filter paper in bag in fume hood.
- d. Clean all glassware and then wash your hands,**
- e. Sit back down with your goggles at your desk ☺.

Agenda

**S'mores limiting reagent stiochiometry
lab**

Objective

**You will APPLY your KNOWLEDGE
of Stiochiometry to create a delicious
treat!**

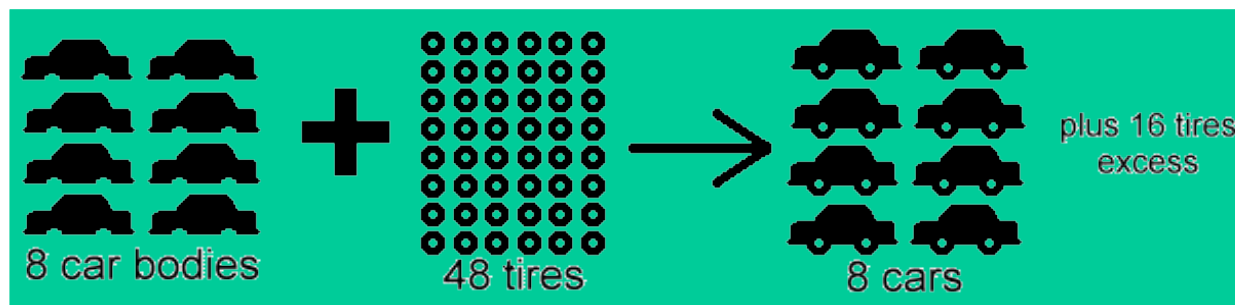
S'mores Lab

You will be making one these in the lab...



S'mores Lab

S'mores are just like stiochiometry and chemistry
you are limited to how many you can make,
through this we briefly look at the concept of
limiting reagent,



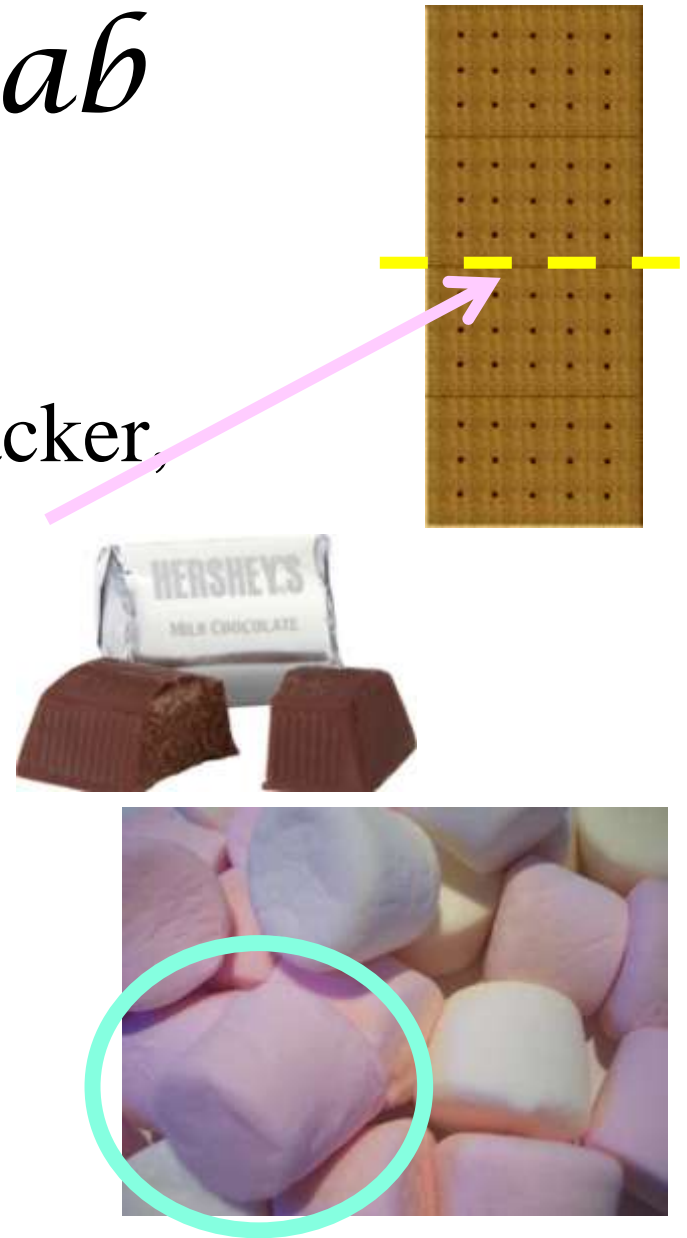
S'mores Lab

A few changes:

You will use one (1) gram cracker,
which you will split in half

ONE (nugget) of chocolate

One marshmallow



What is Due when

Finish “Fe/ CuSO₄” analysis questions
(due 15.Feb.2017)

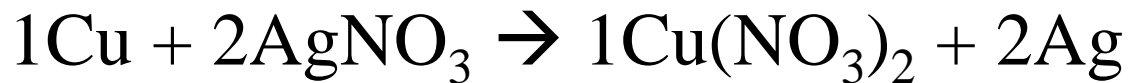
Complete #1-4 in S’mores Lab, save
remainder for later in the week

Worksheet for basic Stiochiometry, turn
in 15.Feb.17

Bell Work

15-Feb-2017

2.0g of both Cu and AgNO₃ are reacted



- (a) How many grams of silver are formed from 2.0 grams of copper?
- (b) How many grams of silver are formed from 2.0 grams of silver nitrate?
- (c) Identify the following in the question above:
 - Limiting reagent
 - Non limiting reagent

EQ: How do limiting reagents impact your daily life?

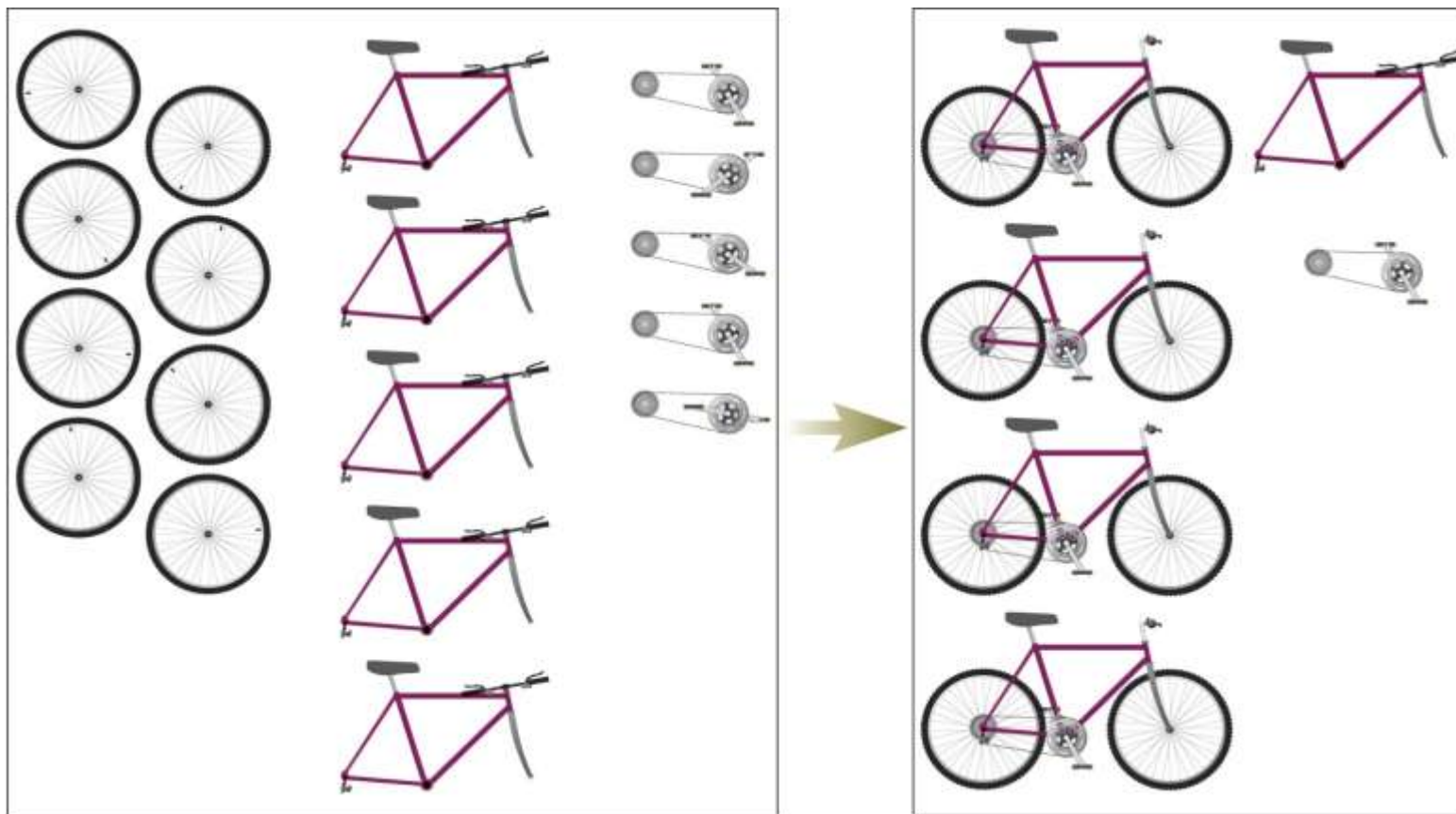
Objective

You will begin to use and practice various applications of limiting reagents

Discuss what is needed to finish science fair projects

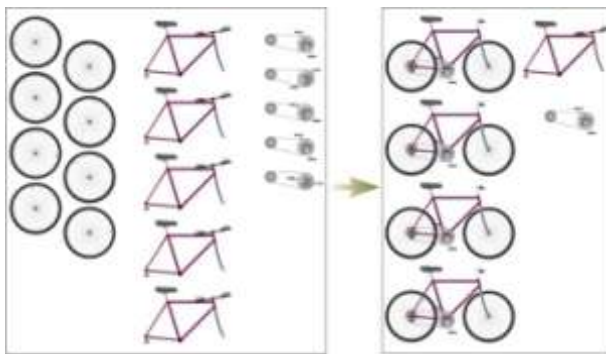
Limiting Reagent

The reactant that is completely consumed by the reaction.



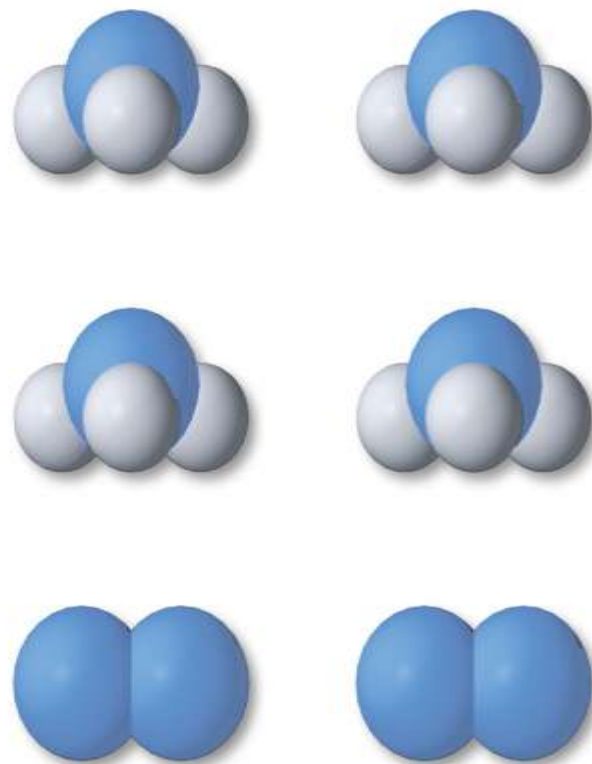
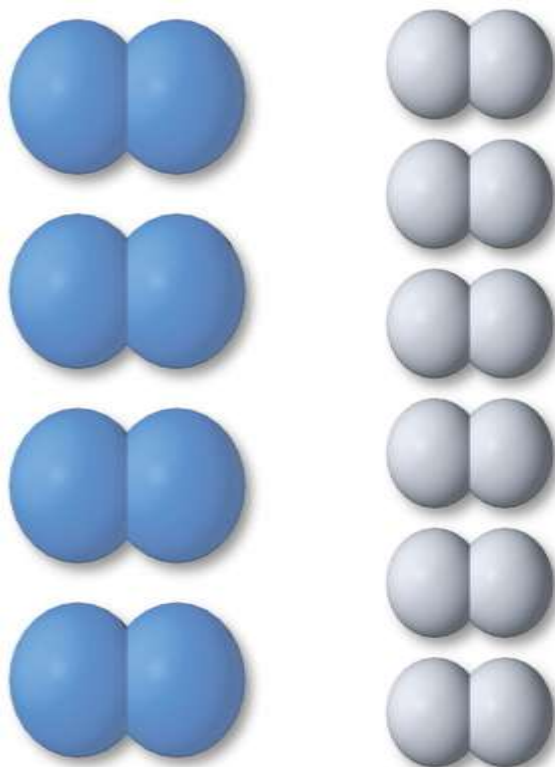
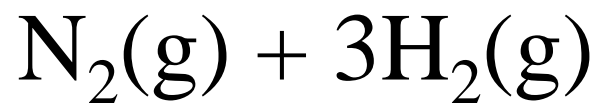
Limiting Reagent

The reactant that is completely consumed by the reaction

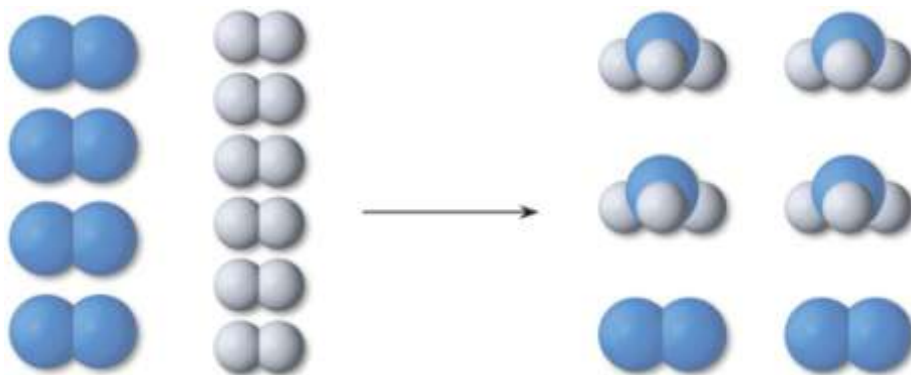


The number of bicycles that can be assembled is limited by whichever part runs out first. In the inventory shown in this figure, wheels are that part.

Limiting Reagent



Limiting Reagent



A molecular view of a Limiting reactant situation for the ammonia synthesis. To make 4 molecules of NH_3 requires 2 molecules of N_2 & 6 molecules of H_2 . If we start with 4 molecules of N_2 and 6 molecules of H_2 , H_2 is the limiting reactant.

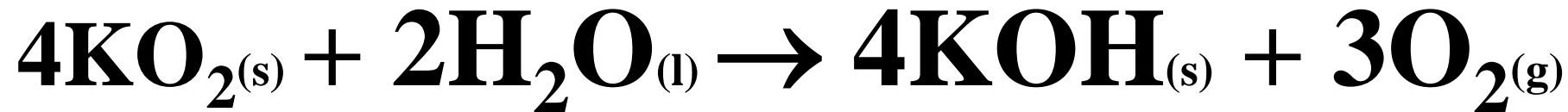
Limiting Reagent

So to find limiting reagents carry out the stoichiometry for each of your reactants that you are given a quantity for.

The reactant that gives you the smallest value of product is your limiting reagent.

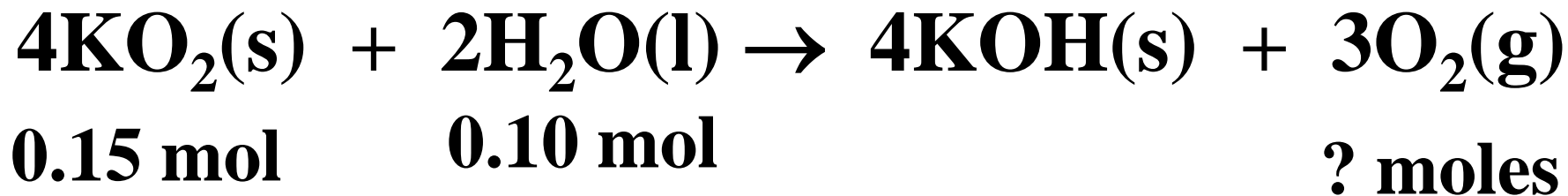
Use this reactant for all calculations

Limiting Reagent



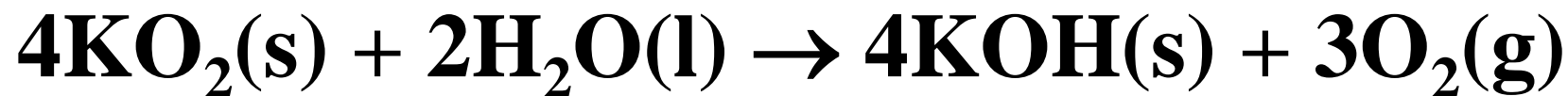
a. How many moles of O_2 can be produced from 0.15 mol KO_2 and 0.10 mol H_2O ?

b. Determine the limiting reactant.



Limiting Reagent

b. Determine the limiting reactant.



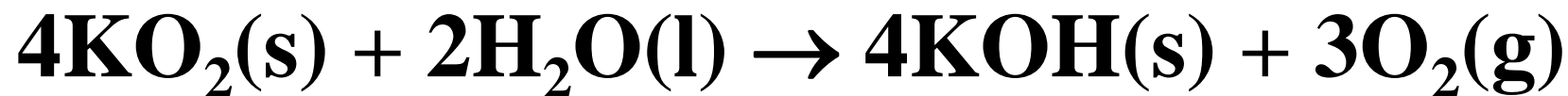
0.15 mol 0.10 mol ? moles

Based on **KO₂** :

$$0.15 \text{ mol } \cancel{\text{KO}_2} \times \frac{3 \text{ mol } \text{O}_2}{4 \cancel{\text{mol KO}_2}} = 0.1125 \text{ mol } \text{O}_2$$

Limiting Reagent

b. Determine the limiting reactant.



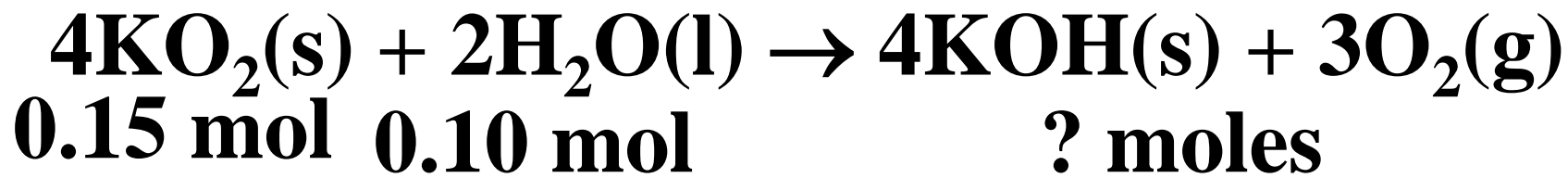
0.15 mol 0.10 mol ? moles

Based on H_2O :

$$0.10 \text{ mol } \text{H}_2\text{O} \times \frac{3 \text{ mol } \text{O}_2}{2 \text{ mol } \text{H}_2\text{O}} = 0.15 \text{ mol } \text{O}_2$$

Limiting Reagent

b. Determine the limiting reactant.

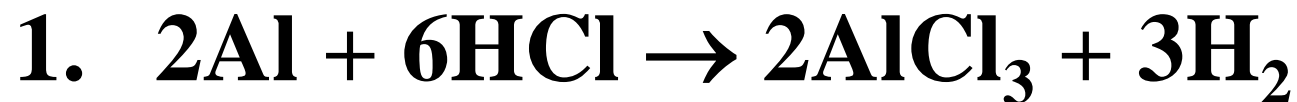


Based on KO_2 : = 0.1125 mol O_2

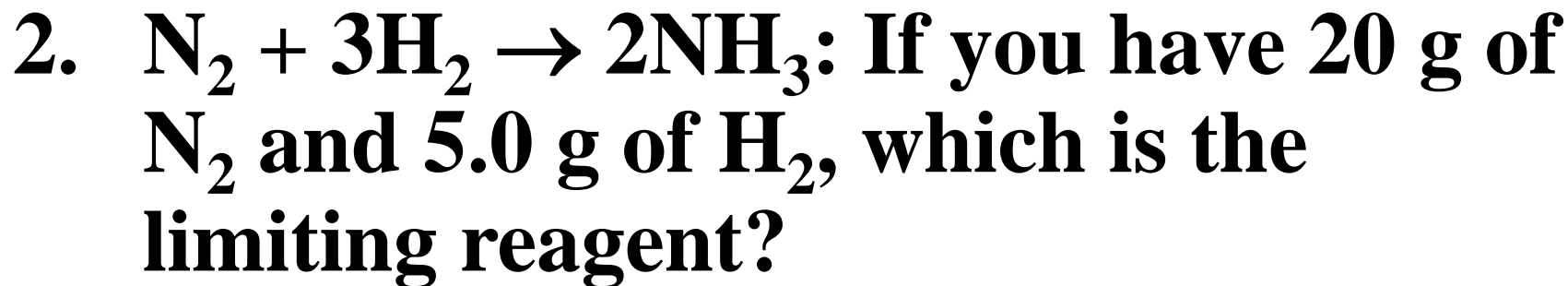
Based on H_2O : = 0.15 mol O_2

KO_2 is the limiting reagent because it limited the amount of O_2 that could be produced. H_2O is the excess reagent.

Practice questions



If 25 g of aluminum was added to 90 g of HCl, what mass of H_2 will be produced?



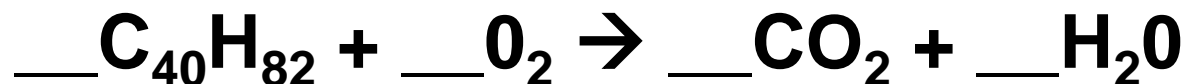
Practice questions

- 2. $\text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3$: If you have 20 g of N_2 and 5.0 g of H_2 , which is the limiting reagent?**
- 3. What mass of aluminum oxide is formed when 10.0 g of Al is burned in 20.0 g of O_2 ?**

Bell Work

16-Feb-2017

Candle wax reacts with oxygen to form water and carbon dioxide through the following chemical reaction:



- 1. Balance the equation**
- 2. If there is approximately 1.1 g of oxygen in the container and the mass of the candle is 0.8 g what is the limiting reagent for this reaction (MM C₄₀H₈₂ = 562 g/mol)?**

EQ: How do limiting reagents impact your daily life?

Objective

You will practice finding limiting reagents and determining theoretical yield of simple chemical reactions

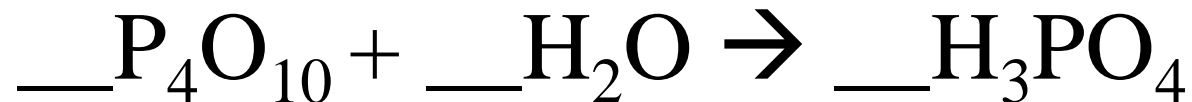
Discuss Science fair Data analysis (brief)

Turn in

- Work Sheet for Basic Stiochiometry
(period 1)

Bellwork

17.Feb.16



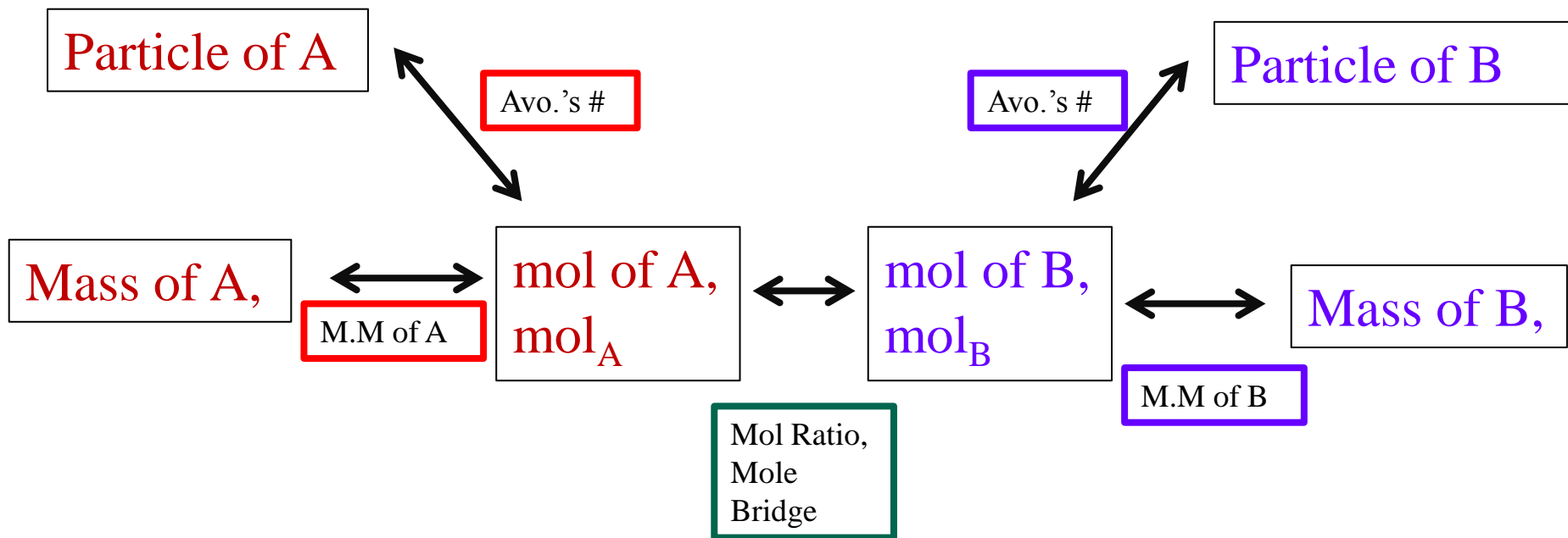
1. 50 grams of P_4O_{10} (M.M. 284g/mol) reacts with 52 grams of water (M.M. 18g/mol) how much phosphoric acid (M.M. 98g/mol) will be produced (grams)?
- ~~2. How much excess reagent is left after the reaction is complete?~~

EQ: How do limiting reagents impact your daily life?

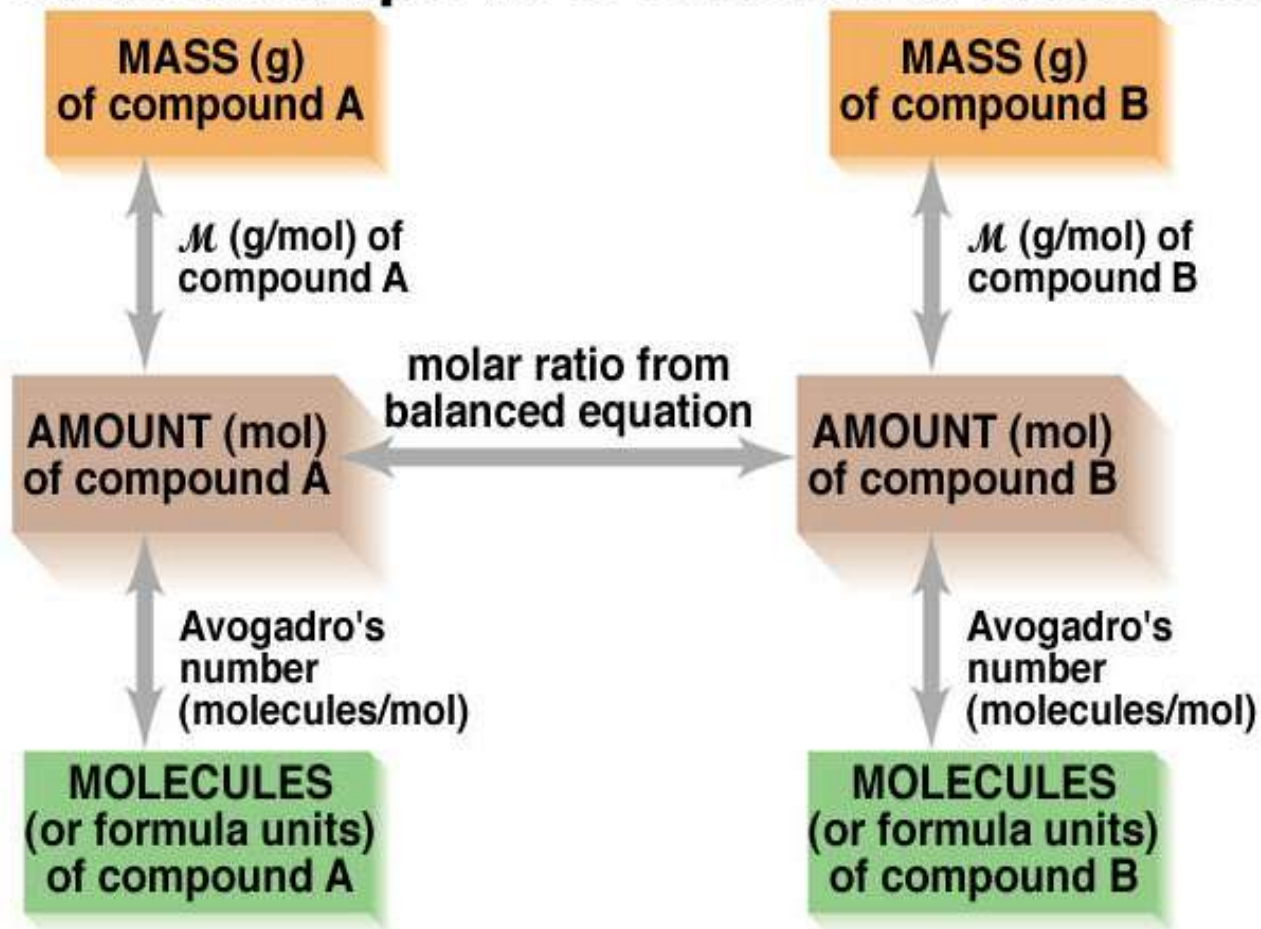
Objective

You will see practice limiting reagents calculation in small groups

Stoichiometry Flow Chart



Summary of the Mass-Mole-Number Relationships in a Chemical Reaction



Homework 17-Feb-17

- Finish 1, 3, 4, 5, and 6 form Limiting Reagents Tutorial
- Science Fair Graphs and Conclusions

Bell Work

20-Feb-2017

What is the difference between a limiting and non-limiting reagent?

For the balanced equation shown below how much non-limiting reagent would remain if 26.0g of C₃H₉N reacted with 46.3g of O₂?



EQ: What is left over after everything else has run out

Objective

You will see limiting reagents in the lab

Limiting Reagent Lab

You will work in groups of at your lab bench

The molar ratio will be:

4people
6rxns

Or **4people**
6balloons

Limiting Reagent Lab

Person A mass out of NaHCO_3

Person B help Person D Clean
and dry all test tubes, **do not
over use paper towels!**

Person C will use a 10mL
graduated cylinder to obtain
the $\text{HC}_2\text{H}_3\text{O}_2$

Limiting reagents
are so easy! I
figured it out, even
after pooping my
pants



Before you go

List the steps you would use to determine how to find the amount of the non-limiting reagent that is left over from a reaction.

Bell Work

21-Feb-2017

For the balanced equation you got a 75% yield in the production of NO_2 (M.M. 46g/mol) from 16.0g of $\text{C}_3\text{H}_9\text{N}$ (M.M. 59g/mol) reacted with excess O_2 , what was the mass of NO_2 you produced?



EQ: What is left over after everything else has run out

Objective

You will put your science fair board together
in the

Bellwork

22.Feb.2017

1. What are indicators of a chemistry problem being a limiting reagent based calculation?
2. In five or less steps list the method for determining the amount of excess reagent left over in a reaction.

Agenda

Limiting Reagent Baking Soda and Vinegar

Objective

Use visual indicators to determine LR and compare to theoretical get more practice with calculations involving limiting and excess reagents

Limiting Reagent Lab



- How did you determine the limiting reagent?
- Was the $\text{HC}_2\text{H}_3\text{O}_2$ always the limiting reagent?
- What issues arose in the experiment?

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Percent mass by volume

% (m/v) Xg/100mL,

Example:

If a solution is 3%(m/v) we will consider it to be 3g/100ml, so for a 3% HCl solution that is 5mL you can get grams of HCl by the following:

$$\frac{5\text{mL}}{1} \times \frac{3\text{g}}{100\text{mL}} = 0.15\text{g HCl}$$

Due 27.Feb.17

- Limiting Reagent Lab

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